

Introduction to the optics and the brain 2015 feature issue

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Guest Editors

Abstract: The Optics and the Brain conference brought together leaders in the neuroscience optics field whose contributions are significantly advancing the state of the art in biological and medical research through the development and implementation of innovative optical technologies. In this conference, the latest advances in neurophotonic imaging, novel optical modulation approaches and applications across scales from small organisms to clinical settings were presented.

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OCIS codes: (000.1200) Announcements, awards, news, and organizational activities.

References and links

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The application of optics to the field of neuroscience is increasingly gaining attention because of the high specificity and flexibility it affords in terms of spatial, temporal and spectroscopic resolution. Emerging microscopy and optical imaging techniques are paving the way to unravelling previously inaccessible facets of brain anatomy and functionality allowing investigations at all scales of its morphology, biochemistry and molecular make-up. Optogenetics has delivered the ability to stimulate and inhibit the activity of precisely selected brain cells to enable truly interactive neuroscience investigations at the cellular level. Recent

advances in the development of optical techniques have led to an ever-increasing and truly unique role for optics in addressing neuroscientific challenges ranging from molecular-level investigations to their clinical translation towards improved treatments for patients affected by brain conditions. The extensive progress in instrumentation development and the subsequent application of the toolkits offered by optical methods permit multilevel studies that were not conceivable just a few years ago.

The Optics and the Brain conference brought together leaders in the neuroscience optics field whose contributions are significantly advancing the state of the art in biological and medical research through the development and implementation of innovative optical technologies. In this conference, the latest advances in neurophotonic imaging, novel optical modulation approaches and applications across scales from small organisms to clinical settings were presented.

This feature issue of *Biomedical Optics Express* collects up to date contributions from participants of the Optics and the Brain symposium. A broad range of topics is addressed, from recent advances in small animal imaging to novel optical tools for clinical investigation.

In detail, the contributed papers show improvements in linear and non-linear imaging for visualizing and manipulating brain structure and function. Three of the special issue's papers describe important advances in non-linear microscopy, reporting on two-photon microscopy with improved mechanical flexibility for *in vivo* imaging [1], label-free NIR imaging of axons and blood vessels in the brain of live mice [2], and brain activity manipulation in behaving *Drosophila* flies with two-photon excitation of red-shifted opsins [3]. In addition, two examples are provided of multi-parametric brain metabolism measurements: the combination of optical coherence tomography with Doppler and spectroscopic capabilities is shown to provide a direct measure of the cerebral metabolic rate of oxygen [4], while optical coherence tomography combined with laser speckle imaging is used to study the mechanisms of stress-induced brain injury [5]; further, spectral-domain optical coherence tomography for visualizing details of zebrafish brain morphology *in vivo* is reported [6]. Finally, new tools for *in vivo* human brain imaging are presented. Progress in fluorescence guided surgery [10] now provide surgeons with more intuitive and accurate image renderings [7] and give them standardized quantitative maps of fluorescent markers during a procedure; interstitial optical tomography is presented as a guide to improve the safety of biopsy procedures [8] and an application of fNIRS imaging of brain activation is shown [9].

Taken together, these manuscripts provide excellent examples of the highly productive, diverse and increasingly crucial role of optics and microscopy in contemporary brain research.